18. This approach is not capable of dealing with all the issues either. The intensity-of-use technique is unable to isolate the effects of changes in the quality of a material on its demand (for example the development of new alloys), nor is it possible to distinguish between the effects of intra-material substitution and the effects of material saving technologies (which would require using input-output tables that are not available for a large number of industries and countries). However, the intensity-of-use technique can be used as a complement to other methodologies, so as to obtain a broader perspective on the interrelationship between various factors influencing commodity-demand growth rates.

All variables in the equation are expressed in volume terms, i.e. GDP in constant prices and consumption in metric tons/cubic metres. The second term in equation (1) is simply the GDP-based intensity of use (IU), which can be rewritten as:

$$C = GDP \times IU \qquad (2)$$

Totally differentiating equation (2) and dividing through, we obtain:

$$\hat{C} = \hat{GDP} + \hat{IU} \qquad (3)$$

where $\hat{C}$ = consumption growth rate
$\hat{GDP}$ = GDP growth rate
$\hat{IU}$ = IU growth rate

17. Equation (3) simply postulates that the growth rate of commodity consumption is the sum of the growth rates of GDP and intensity of use. The actual differentiation is provided in the mathematical appendix, but we should point out here that changes in GDP per se also affect the IU term (as discussed in the appendix). Therefore, the figures presented in this paper underestimate the relative importance of the GDP variable on consumption growth rates. Using this simple formula developed by Tilton, the relative effects of the GDP variable and the intensity-of-use variable on the growth rates of commodities consumption are presented in chapter II. By extending the Tilton formula, the paper attempts to account for the effect of restructuring and provides a better estimate of the role of technological change.

By postulating

$$C = GDP \times (C\backslash MAN) \times (MAN\backslash GDP) \qquad (4)$$

and rewriting equation (4), it follows that

$$C = GDP \times IUM \times RBS \qquad (5)$$

where

IUM = intensity of use in manufacturing value-added
RBS = share of manufacturing value added in GDP

Totally differentiating (5), and multiplying,

$$\hat{C} = \hat{GDP} + \hat{IUM} + \hat{RBS} \qquad (6)$$

where

$\hat{RBS}$ = growth rate of manufacturing value added in GDP, which is used as a proxy for changes in the composition of GDP.

input-demand for metals as a dependent variable, is a linear function of prices of metals, the price of energy, the prices of substitutes, the total output variable and the stock of capital.

$$MTL = \alpha^0 + \alpha^1 O + \alpha^2 PMTL + \alpha^3 PSML + \alpha^4 PEN + \alpha^5 WGE + \alpha^6 K + \alpha^7 t$$

where MTL is the demand for metals, PMTL is the price of metals, PSML is the price of other materials (including substitute metals), PEN is the price of energy, WGE is the wage rate, K is the fixed capital input and t is the time trend picking up technical progress.

14. The advantages of this model as compared to the standard demand model are that it is fully specified, and that it takes into account the effects of the two oil price shocks. To test for the hypothesis that there was a structural change in the demand for metals during the 1970s, Choe performed a series of Chow tests to establish whether there was a significant change in the coefficients following the 1973 oil crisis. The same tests were used to establish the significance of the variables added to this model. Choe concludes that the hypothesis of no structural change in the demand relationship cannot be rejected.

15. However, the approach used by Choe still suffers from the above-mentioned limitation regarding the effects of prices and the exact role of technological change. He finds that technological change positively affected the consumption of *aluminium* and, when a weighted average is taken for the six metals under study (*aluminium*, copper, lead, nickel, tin, zinc), he obtains a positive coefficient for the time trend for metals as a group. This is due to the large weight of *aluminium* in total non-ferrous metal consumption. Although the positive coefficient of the time trend in the equation for *aluminium* can be explained by the increasing substitution of *aluminium* for other metals in a large number of end-uses, this model is not suitable for measuring the impact of technological progress on the demand for *aluminium*. Thus, in Choe's model, the time trend picks up a multitude of factors which have influenced metals demand (among others, the effect of restructuring) and so, for the purposes of this study, this model could not have been used as a reliable estimator of the effects of technological progress and other factors which shape the long-run demand trends.

B. <u>Extending the Tilton model</u>

16. Since the above-mentioned approaches had not been designed to deal with some of the salient long-run features of the demand for raw materials, a model for analysing the dematerialization hypothesis was needed. This has led to the emergence of the intensity-of-use technique (IUT) in order to measure the relative impact of GDP, technology and restructuring on the long-run behaviour of commodity demand. The technique was originally developed by Tilton (op. cit.), and was extensively used to analyse commodity consumption trends. The technique is developed from a simple identity, where:

$$C = GDP \times (C/GDP) \qquad (1)$$

11. A second line of thought has tried to explain the declining rates of growth of raw material consumption by a life-cycle hypothesis. This followed the original work by J. Dean, 9\ which was later developed by G.W. Bain. 10\ The theory's applicability is limited to the study of the behaviour of the demand for metals and minerals, and it does not explicitly explain the declining intensity of use of agricultural raw materials. Although it could be extended to deal with this group of commodities, it would not be useful for the purposes of estimating the effects of technological progress on the demand for raw materials. Although the life-cycle hypothesis can be used to gain some interesting insights regarding the consumption trends of some metals and minerals, it is too vague for the purposes of drawing conclusions about the relative contributions of structural as opposed to cyclical factors affecting commodity demand. The life-cycle hypothesis postulates that metals go through a phase of youth, maturity, old age and decline. The length of each phase is determined by technological advances occurring in the production process, by inter-material competition and by the relative prices of metals. However, the set of propositions advanced by this approach is not testable since no formal model has been presented in support of the theory. Thus, in some end-uses, a metal may be in its first or second stage, whereas in other end-uses it may have reached the third or fourth stage. Also, in some geographical regions, a material may be in its mature stage while in another region it might be in its infancy. Moreover, the theory is too general, failing to account for cases where the metal does not exhibit the set pattern, for example owing to a technological breakthrough in the production process or because of the development of a substitute. It cannot be ruled out that some natural material, which seem to have entered the phase of decline according to the life-cycle hypothesis, get a new lease on life because of changing consumer tastes, technological developments or changes in energy prices (cotton, natural rubber and wood are cases in point).

12. An econometric approach for explaining lower raw-material demand growth rates consists of setting up a demand equation with the following explanatory variables: the price vector of the commodities under study; the price vector of close substitutes; the GDP variable which picks up the level of economic activity; and a "time" variable which is interpreted as the effect of technological change on the demand for raw materials. This approach has been primarily developed for analysing short-run demand trends. The reason behind the inadequacy of such models to deal with long-run trends could be that prices do not affect commodity demand in a continuous way or that they have a strong indirect effect on demand. The former is supported by empirical evidence suggesting that prices influence firm decision to substitute for another material only at some threshold level which implies a kinked demand function. The indirect effect operates through the incentive to firms to intensify research into material saving technologies or the development of substitutes following an increase in the price of raw materials. This type of firm behaviour is supported by various case studies. 11\

13. Another problem with standard demand equations, as Boum-Jong Choe 12\ points out in his study on metals demand, is that the orthodox demand model is unspecified if commodities and energy are complements in production. Therefore, he estimates an extended metals demand equation derived from the firm's aggregate cost function. The estimated demand equation, with the

I. EXTENDING THE INTENSITY-OF-USE TECHNIQUE

A. Review of the existing literature

8. The literature on commodity demand can be divided into two groups of models. The first group tries to identify the long run determinants of consumption growth and focuses on structural shifts in the economy as it moves along a development path. The second group of models tries to identify medium-term factors which affect raw-materials demand. These models use an econometric approach, where the prominent variable affecting the result is the price vector of inputs used in the production of a final good.

Figure 1

9. The explanation for the lower growth rates of raw-materials demand suggested by Malenbaum 7\ relates the evolution of the intensity of use to the level of per capita income in the economy. This is known as the "intensity-of-use hypothesis," where the intensity of use is an inverted U-shaped curve in the intensity-of-use and per capita income space (see fig. 1).

10. However, Malenbaum's hypothesis has drawn some criticism from academic circles. First, the relationship between the growth rates of the per capita income variable and the evolution of intensity of use is not formally modelled; thus it is impossible to estimate at what level of per capita income the intensity of use should start declining. Secondly, Malenbaum did not provide a robust theory to explain the economic channels through which per capita incomes affect the growth rates of intensity of use. The suggestion that per capita income can be used, inter alia, as a proxy for intersectoral restructuring (i.e. the service sector expands at the expense of the manufacturing sector) which is supposed to cause the decline in the intensity-of-use growth in DMECs was found to be questionable. Moreover, the recent work undertaken by Humphreya 8\ further questions the validity of Malenbaum's hypothesis. Humphreya has studied the evolution of the intensity-of-use index of non-ferrous metals for the period 1900-1985 in the industrialized countries and has found no close correlation between the evolution of the intensity of use and the growth rates of per capita income.

for this phenomenon. However, as more recent works have suggested (not only in the field of commodity-demand trends but also in other fields such as studies on labour-productivity growth in OECD countries), the period 1950-1973 might have been atypical of the longer term historical trends, in which case the commodity growth rates we have been observing over the last 25 years should not be interpreted as being exceptionally low.

4. The paper is divided into four chapters. Chapter I contains a short review of the literature and outlines the work that has been done so far. It presents some of the main findings and explanations advanced by various authors for the declining growth rates of materials demand.

5. Chapter II presents estimates on consumption trends, GDP growth rates and the evolution of the intensity of use for 20 industrial materials for the period 1965-1988 6/ and assesses the relative impact of each variable on the demand growth rates of raw materials. In order to isolate the effect of structural and technological change, the intensity-of-use variable is then divided into the intensity of use in manufacturing value-added and the share of manufacturing value-added in GDP. For DMECs, the chapter takes a closer look at the process of intra-sectoral restructuring in the manufacturing sector by selecting branches that use raw materials intensively. The evolution of their share in GDP is estimated in order to assess the importance of intra-sectoral restructuring on commodity demand during the 1970s and 1980s. On the basis of these results, an evaluation is given of the hypothesis of "decoupling" of GDP growth and the demand for commodities.

6. Chapter III assesses the importance of country groups relative to total demand for raw materials. Taking various assumptions about GDP growth rates and the rate of technological progress in DCs, the chapter looks at the potential of DCs to become important final consumers of raw materials. A hypothetical evolution of commodities-demand trends extrapolated from trends prevailing in the 1960s and early 1970s is used to evaluate the effects of the break in the growth rates of demand that occurred after the oil price hikes. In the same context, the potential for demand to pick up in the future is estimated.

7. Chapter IV draws the general conclusions which emerge from the analysis.

Summary

1. The last two decades have witnessed a sharp decline of growth rates in consumption of non-fuel raw materials. This implies a declining rate of growth of receipts stemming from the exports of this group of goods. Since a large number of developing countries earn a considerable proportion of their foreign exchange from the export of raw materials, the change in the evolution of raw materials consumption is of particular concern to them. Thus, in the late 1980s, among 146 developing countries and territories, 81 relied on non-fuel commodities for at least 50 per cent of their export earnings; of these, 39 were least developed countries for most of which commodity exports represent 80 per cent of export earnings. 1/ The issue for developing countries is whether the current slack commodity demand is a consequence of the economic slow-down, which could be reversed in future, or whether it is a reflection of structural change and technological innovation, which will persist or even intensify. Although the question of raw-material consumption trends has been studied over a number of years, the question of the relative impact of various factors affecting the final consumption of raw materials remains of great interest, in particular for raw-material exporting countries. In particular, the issue of the possible "decoupling" of GDP growth from raw-material demand growth is still of major concern to developing countries.

2. It is the purpose of this paper to examine consumption 2/ trends of non-fuel, non-food raw materials based on an extended coverage. 3/ The paper analyses the relative importance of technological advances as compared with other economic forces that have shaped the observed behaviour in raw materials demand during the 1970s and 1980s, with a special emphasis on the post-1973 period. Estimates of the relative contributions of lower rates of GDP growth, cross-sectoral and intra-sectoral restructuring, as well as technological change, to the declining rates of growth of raw materials demand are presented. As a point of departure, the analysis is based on the intensity-of-use technique (IUT) as developed by Tilton, 4/ which is a growth accounting formula and not an econometric model. It is then applied to several country groups (developed market economy countries (DMECs), developing countries (DCs), developing Asia and America). The study assesses the trends in the intensity of use (intensity of use is defined as a physical amount of consumption of a commodity per unit of GDP at constant prices) in each country and commodity group. The methodology is then broadened in order to account for changes in intensity of use due to technological progress (which includes both the introduction of new production technologies and intra-material substitution) and those owing to the process of economic restructuring. Previous work by the UNCTAD secretariat in this domain had focused on the examination of technological progress as reflected in the intensity-of-use trends, and its impact on commodity consumption growth. This report, which builds on the previous findings of the secretariat, 5/ assesses the relative contribution of intensity of use and GDP growth on commodity demand growth rates.

3. A large part of the discussion on commodity consumption trends might be misleading as a result of the choice of periods studied in the literature. Namely, most studies, including this one, tend to compare the periods of the 1950s and 1960s to the period of the 1970s and 1980s. More often than not, decline in their growth rates and various explanations are advanced to account the general conclusion seems to be that natural materials have suffered a

Preface

This report was prepared pursuant to resolution 33 (VIII) of the Committee on Transfer of Technology, which recommended that the secretariat continue to give attention to the impact of micro-electronics and new materials on trade and development opportunities of developing countries. The report examines the relative contribution of continuing technological advances on commodity consumption.

CONTENTS

		Page
Preface		4
Summary		5
I.	Extending the intensity-of-use technique	7
A.	Review of the existing literature	7
B.	Extending the Tilton model	9
II.	Commodity demand growth rates: Causes for their decrease	12
A.	Evolution of commodity consumption and intensity of material use	12
B.	The relative contributions of various factors to consumption growth	13
III.	Commodity demand until the year 2000: Sensitivity analysis among the main determinants	26
A.	The relative weights of regions in world consumption	26
B.	Can the 1990s bring about a turn in growth rates of commodity consumption?	28
IV.	Concluding remarks	31
V.	Mathematical Appendix	33
Notes		34
Statistical Annex		39

Note

The designations employed and the presentation of the material in this publication do not imply the expression of any opinion whatsoever on the part of the Secretariat of the United Nations concerning the legal status of any country, territory, city or area, or of its authorities, or concerning the delimitation of its frontier or boundaries.

Distr.
GENERAL

UNCTAD/ITD/TEC/14
13 April 1994

ENGLISH ONLY

UNITED NATIONS CONFERENCE ON TRADE AND DEVELOPMENT

TECHNOLOGY AND RAW MATERIALS DEMAND

94-51540 (E)

Table 8

Manufacturing in OECD Countries
Share of World Total Inventive Branches

Branches according to ISIC		1970	1971	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991
351	textile	4.62	4.68	4.55	4.33	4.04	3.82	3.73	3.62	3.52	3.42	3.30	3.34	3.30	3.12	3.02	3.03	2.97	3.01	2.90	2.84	2.82	2.82
352	wearing apparel	5.33	5.30	5.23	5.13	5.14	5.31	5.40	5.43	5.44	5.43	5.41	5.30	5.18	5.13	5.05	4.93	4.84	4.81	4.77	4.73	4.71	4.70
353	leather products	0.73	0.72	0.70	0.70	0.70	0.71	0.72	0.73	0.74	0.74	0.74	0.74	0.74	0.74	0.74	0.74	0.74	0.74	0.74	0.74	0.74	0.74
354	footwear	1.43	1.40	1.41	1.41	1.39	1.39	1.39	1.39	1.39	1.39	1.39	1.39	1.39	1.39	1.39	1.39	1.39	1.39	1.39	1.39	1.39	1.39
355	rubber products	2.10	2.02	1.99	1.98	1.96	1.95	1.94	1.93	1.92	1.91	1.90	1.89	1.88	1.87	1.86	1.85	1.84	1.83	1.82	1.81	1.80	1.79
356	plastic products	1.83	1.84	1.88	1.92	1.95	1.98	2.01	2.04	2.07	2.10	2.13	2.16	2.19	2.22	2.25	2.28	2.31	2.34	2.37	2.40	2.43	2.46
361	pottery, china, earthenware	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10
362	glass products	0.77	0.77	0.77	0.77	0.77	0.77	0.77	0.77	0.77	0.77	0.77	0.77	0.77	0.77	0.77	0.77	0.77	0.77	0.77	0.77	0.77	0.77
369	other non-metallic minerals	1.43	1.43	1.43	1.43	1.43	1.43	1.43	1.43	1.43	1.43	1.43	1.43	1.43	1.43	1.43	1.43	1.43	1.43	1.43	1.43	1.43	1.43
351 - 369		17.54	17.46	17.36	17.27	17.18	17.10	17.04	16.98	16.92	16.85	16.78	16.72	16.65	16.55	16.46	16.36	16.25	16.23	16.13	16.04	15.96	15.91
371	iron and steel basic industries	3.11	3.11	3.11	3.11	3.11	3.11	3.11	3.11	3.11	3.11	3.11	3.11	3.11	3.11	3.11	3.11	3.11	3.11	3.11	3.11	3.11	3.11
372	non-ferrous basic industries	3.15	3.15	3.15	3.15	3.15	3.15	3.15	3.15	3.15	3.15	3.15	3.15	3.15	3.15	3.15	3.15	3.15	3.15	3.15	3.15	3.15	3.15
381	metal goods n.e.c.	3.81	3.81	3.81	3.81	3.81	3.81	3.81	3.81	3.81	3.81	3.81	3.81	3.81	3.81	3.81	3.81	3.81	3.81	3.81	3.81	3.81	3.81
382	machinery except electrical	3.84	3.84	3.84	3.84	3.84	3.84	3.84	3.84	3.84	3.84	3.84	3.84	3.84	3.84	3.84	3.84	3.84	3.84	3.84	3.84	3.84	3.84
383	machinery electric	3.11	3.11	3.11	3.11	3.11	3.11	3.11	3.11	3.11	3.11	3.11	3.11	3.11	3.11	3.11	3.11	3.11	3.11	3.11	3.11	3.11	3.11
384	transport equipment	3.81	3.81	3.81	3.81	3.81	3.81	3.81	3.81	3.81	3.81	3.81	3.81	3.81	3.81	3.81	3.81	3.81	3.81	3.81	3.81	3.81	3.81
385	professional goods	3.22	3.22	3.22	3.22	3.22	3.22	3.22	3.22	3.22	3.22	3.22	3.22	3.22	3.22	3.22	3.22	3.22	3.22	3.22	3.22	3.22	3.22
390	other manufactured products n.e.c.	3.21	3.21	3.21	3.21	3.21	3.21	3.21	3.21	3.21	3.21	3.21	3.21	3.21	3.21	3.21	3.21	3.21	3.21	3.21	3.21	3.21	3.21
371 - 390		27.28	27.28	27.28	27.28	27.28	27.28	27.28	27.28	27.28	27.28	27.28	27.28	27.28	27.28	27.28	27.28	27.28	27.28	27.28	27.28	27.28	27.28

Table 5

Average Annual Rates of Growth of GDP and Intensity of Use for Period

		1970-1973	1974-1983	1984-1988
World	GDP	4.31	2.41	3.80
World	====) Intensity of use (Consump/GDP)			
World	Agri.raw mat.	-2.39	-2.55	2.99
World	Total wood	-2.12	-0.61	-1.14
World	Metals + minerals	0.53	-1.58	-1.18
World	Total steel	-4.11	-2.33	-3.65
DMECa	GDP	4.05	2.16	3.73
DMECa	====) Intensity of use (Consump/GDP)			
DMECa	Agri.raw mat.	-3.39	-3.88	0.42
DMECa	Total wood	-1.90	-1.40	-0.17
DMECa	Metals + minerals	-0.38	-2.22	-1.66
DMECa	Total steel	-3.87	-2.09	-3.60
DCs	GDP	5.63	3.59	4.06
DCs	====) Intensity of use (Consump/GDP)			
DCs	Agri.raw mat.	-1.99	-2.01	2.58
DCs	Total wood	-3.37	-0.96	-2.28
DCs	Metals + minerals	12.48	2.82	1.14
DCs	Total steel	-5.29	-3.39	-3.86
damerica	GDP	5.44	3.30	2.72
damerica	====) Intensity of use (Consump/GDP)			
damerica	Agri.raw mat.	1.73	-3.86	4.08
damerica	Total wood	-2.73	0.24	-1.07
damerica	Metals + minerals	10.03	2.36	2.87
damerica	Total steel	-5.12	-3.12	-2.63
dasia	GDP	5.81	3.77	5.14
dasia	====) Intensity of use (Consump/GDP)			
dasia	Agri.raw mat.	-3.26	-1.29	1.47
dasia	Total wood	-3.79	-1.52	-3.18
dasia	Metals + minerals	11.19	3.67	0.02
dasia	Total steel	-5.45	-3.52	-4.79

46. In DCs, restructuring could not have played an important role since these countries are still industrializing rather than de-industrializing. Thus, half of the decrease in the consumption growth rate is attributable to the lower rates of GDP growth. The striking result is the positive contribution of restructuring in developing Asia which was entirely offset by lower growth rates of IUM. This provides some support to the hypothesis of "leap-frogging", since it shows that despite the process of rapid industrialization, the introduction of new technologies can entirely offset the positive effect of the growing share of manufacturing in GDP. Again, there are two possible channels through which technology may affect consumption, but both can be grouped under the category of skipping stages of development. First, if growth of the manufacturing sector was heavily influenced by the growth of the electronics sector, then IU in manufacturing could have been decreasing despite the growth of the share of manufacturing in GDP. Secondly, even in the part of the manufacturing sector that uses steel intensively (e.g. heavy industry and shipbuilding) the introduction of new material-saving technologies permits a decrease in the growth rates of IUM, and can thus offset the effect of the growth of the share of manufacturing in GDP. This is supported by a study done by Hwang, 26\ which looked at the use of steel by industry in the Republic of Korea. It indicates that between 1973 and 1983 the use of steel per unit of output declined by 71 per cent in power-generating machinery, 62 per cent in non-residential construction, and 57 per cent in both metal-working machinery and public works. The data for the 1980s for South/South-East Asia shows that the relative importance of the IU variable increased even further during that period, which offset the otherwise positive effect of the difference in GDP growth on consumption during the period 1984 to 1988.

43. In DCs an entirely different situation may be observed for the period 1974 to 1983 compared to 1970 to 1973. The difference in the growth rate of IUM accounted for 75 per cent of the decrease in consumption growth rates, and was even stronger in developing Asia (95 per cent). Such a strong contribution of IUM invariably points to a large impact of technology on consumption growth during the period. The same pattern was observed for the 1980s (the contribution of IUM in DCs being 78 per cent and in developing Asia, 93 per cent).

44. The explanation for the trend like in pre-1973 production techniques, which tended to use raw materials relatively intensively. The 1973 energy crisis spurred industry to find ways to improve its competitiveness in the light of contracting markets and tougher competition. Whereas, in the DMECs, materials saving technologies developed during the 1960s and 1970s were already in place, in the DCs the scope for improving efficiency through the introduction of such technology was *much* greater. Thus, under the pressure of increased oil prices (note that Chos had found energy and NFMMs to be complements in production), there was a strong incentive to cut down on input. Moreover, since the diffusion of new technology occurred first in DMECs, and only then spread to DCs, the two effects combined to produce a big decrease in the rates of growth of intensity of use during the 1970s and 1980s. However, the intensity of use in DCs is still growing, although the rates of growth have dropped from 11.2 per cent at the beginning of the 1970s to 2 per cent by the late 1970s and to 0.5 per cent in the 1980s. Such dramatic declines in the rates of growth of IUM provide some support to the thesis of "leap-frogging", which postulates that DCs do not need to follow the same pattern of IU evolution as DMECs, since they have the possibility to skip development stages by immediately introducing the latest technology. This hypothesis is also supported by the data on regional contributions of IUM effects. The largest contribution of IUM occurred in Asia (all results for developing Asia are strongly dominated by the performance of the South-East Asian NICs) where the rate of importe of technology was higher than in developing America, thus pointing to the conclusion that leap-frogging occurred in both regions but was more important in Asia. This could have been caused by foreign exchange constraints on importe of new technology to developing America. It is worth noting that the rates of growth of IUM for the subgroup South/South-East Asia became negative in the 1980s, pointing to the fact the NICs might have started to replicate the recent trends in IU growth in the DMECs.

steel

45. The decline in the consumption growth rates of steel in the world was owing to decreased growth rates of IUM, GDP and restructuring, in approximately equal proportions. Both the effects of IUM and restructuring were stronger in DMECs than in DCs, which may be explained by their different stages of development. At the initial stages of development, steel plays an important role since infrastructure and heavy industry tend to use steel intensively. However, in DMECs the steel-intensive sectors have been loosing in importance, while the decreasing role of manufacturing in GDP adversely affects steel consumption growth. Moreover, technological progress (both material saving technology and material substitution) increasingly affect the IU of steel (e.g. the use of steel in the car industry sharply declined during the 1970s).

counterbalance the negative effects of restructuring. The very good performance of IUM was observed in the DMECa and to some extent in developing Asia (although the data for the latter did not satisfy the conditions established for it to be considered as reliable).

39. On the other hand, developing America conflicts with the general trend: one finds that a decrease in IUM growth rates was the main cause for the decline of consumption growth rates. There is some evidence of the total reversal of this trend in the 1980s, where IUM contributed positively to the consumption growth rates during that period. To explain why there was such a particular situation in developing America during the 1970s, one would need to extend the analysis and conduct case studies at the industry level.

40. During the 1980s, it was again difference in IUM growth rates that pushed up consumption growth rates in DMECa and DCa, whereas restructuring and GDP still affected consumption growth rates adversely. However, since GDP growth rates had picked up somewhat in the 1980s (albeit still below the level of the early 1970s), their negative effect was smaller than in the period 1974 to 1983.

NFMMa

41. The relative contribution of restructuring to the decline of world consumption rates of NFMMa was 40 per cent in the period 1974 to 1983 whereas the decline in the rates of growth of IU in manufacturing contributed only 12 per cent. The relative contribution of IUM in the DMECa was even lower, only 4 per cent. This essentially means that there is no strong evidence of an acceleration of the rate of technological progress following the 1973 oil crisis, i.e., technology continued negatively to influence consumption growth, but not more so in the late 1970s as compared to the early 1970s. Moreover, there is evidence that the pace of decline of IUM slowed down in the 1980s in the DMECa, as shown below.

Period:	1970-1973	1974-1984	1984-1988
IUM growth rates:	-1.47	-1.64	-0.91

42. Two different processes should be examined in order to understand these results. First, the IUM measure incorporates both the effects of inter-material substitution and the introduction of material saving technology. Thus, if the two move in opposite directions, their joint effect tends to be small. Case studies on the use of *aluminium* in the automobile and the container industry point to this effect. Material saving technology has played an important role, but the extremely good performance of *aluminium* in competition with other materials seems to have offset losses in terms of smaller amounts of *aluminium* needed to produce an additional dollar of value added. Since *aluminium* weighs heavily in the category NFMMa, and it did well in competing with other materials, the effects of material saving technology were offset. As the technology effect is the sum of the effects of material saving technologies and material substitution, the technology effect did not contribute much to the decrease of consumption growth rates.

36. The investigation of restructuring is, in general, confined to changes in intersectoral patterns. Data constraints (the lack of consumption data per manufacturing branch) did not allow a consistent analysis of the effect of intrasectoral restructuring. Even so, changes in the weight of material intensive branches in manufacturing for the OECD countries are given in table 6. While the share of manufacturing in GDP in the OECD region remained more or less unchanged in the period under review (hovering between 25 to 26 per cent of GDP at constant 1980 dollars) the weight of material intensive branches in OECD manufacturing eased by 7 per cent. This lends support to the conclusion that intra-sectoral rather than cross-sectoral shifts have dominated restructuring and thus commodity demand in DMECs.

37. IUM is regarded as a proxy for tracing the contribution of technological change to the dynamics of commodity consumption. The results of the investigation of IUM should be interpreted with caution as, for lack of consistent country data on the sectoral pattern of commodity consumption, it was not possible to confine consumption for IUM estimates to commodities consumed exclusively in manufacturing. It must be stressed that construction is the biggest non-manufacturing consumer of materials, but is not included in the study. Drawing on the sectoral pattern of consumption in several DMECs, construction can be assumed to account for 20 to 30 per cent of total consumption of the most important commodities. 22\ Despite the fact that the analysis does not use specific data on material consumption in manufacturing, assuming that commodity consumption growth in manufacturing and construction have moved in the same way, 23\ the results concerning the growth rates of IUM should not be overly affected. However, estimates of the levels of IUM would be upwardly biased.

ARMs

38. For the period 1974 to 1983, results at a disaggregated level have a much greater explanatory power than the ones presented in table 4. For the world, the decline in ARMs consumption growth rates was equally influenced by restructuring (i.e. the declining share of manufacturing in GDP) and by GDP, whereas the IUM, to a certain extent, offsets this joint effect. Somewhat surprisingly, one finds that the growth rates of IUM had already improved during the period 1974 to 1983, although not sufficiently to offset the lower rates of GDP growth and the decline in the share of manufacturing. In table 3, it was the IU variable that positively influenced consumption growth rates in the 1980s. It is now obvious that the process of recovery had started a decade earlier. This could be partly explained by the improved competitive position of natural fibres (particularly cotton) vis-à-vis synthetics, which were adversely hit by the increased real price of petrol during the 1970s. The good performance of cotton was not for its absorbency characteristics, but also owing to technological advances which have permitted the reduction of shrinkage of cotton-made garments. One of the methods used to reduce shrinkage is to use liquid ammonia processing of cotton fabrics prior to garment making. Furthermore, the International Institute for Cotton (IIC) has started special programmes aimed at the further improvement of shrinkage control in cotton knits. 24\ Thus, in the 1980s, with the higher penetration of rubber, 25\ cotton and leather into the world market, the tendency of the improvement in the IUM was reinforced and managed to

reported in the text. In addition, since it was found that the data for wood performed extremely badly at this level of disaggregation, wood has been excluded altogether. One explanation for this poor performance may be that a significant share of wood is consumed as fuel. 21/

Table 4

Changes in the average growth rates of commodity consumption owing to GDP, IU in manufacturing (IUM) and restructuring (RES) (1974 to 1983 compared to 1970 to 1973)

Materials	Difference in the growth rates of consumption 1970-1973 to 1974-1983	Owing to change in		
		GDP	IUM	RES
WORLD				
ARMs	-2.00	0.935	-0.835	0.90
NFMMs	-4.05	0.48	0.12	0.40
Steel	-5.08	0.37	0.30	0.33
DMEC				
ARMs	-2.30	0.80	-0.50	0.70
NFMMs	-3.75	0.51	0.04	0.45
Steel	-6.66	0.30	0.40	0.30
DC				
ARMs	-2.08	0.97	-0.10	0.23
NFMMs	-12.39	0.18	0.75	0.07
Steel	-4.36	0.49	0.36	0.15
DEVELOPING AMERICA				
ARMs	-7.90	0.30	0.45	0.25
NFMMs	-10.40	0.20	0.58	0.22
Steel	-7.90	0.27	0.47	0.26
DEVELOPING ASIA				
ARMs	*	*	*	*
NFMMs	-10.29	0.20	0.95	-0.15
Steel	-4.60	0.45	0.90	-0.35

Source: UNCTAD database and UNIDO tapes.

Note: ARMs = agricultural raw materials
NFMMs = non-ferrous minerals and metals.

the same pattern is observed for DMECa, but in DCa the share of the difference in IU growth accounts for 82 per cent of the decline of consumption growth. Moreover, the decline in consumption growth rates was particularly severe in DCa (-12.39 per cent), which points to a large break with previous consumption patterns. In DCa, as opposed to DMECa, the 1980s did not bring about a recovery in consumption growth despite a recovery in the average growth rates of GDP, implying that the last couple of decades have brought about deep structural changes in the factors that determine consumption growth in DCa. A discussion on the relative effects of technology and restructuring is conducted in section 2.

Steel

33. The decrease in the rates of growth of steel consumption in the 1970s was more severe than that for NFMMa. It was of the order of -5.08 percentage points for the world, and was especially strong in the DMECa. The main cause of the decline in the growth rates of steel consumption is accounted for by a decrease in the growth of IU of steel, both at the world level and in DMECa. For the DCa the decline is evenly spread between GDP and IU in the period 1974 to 1983 whereas, in the period 1984 to 1988, a large part of the decreased consumption is attributable to IU. This result seems to suggest that efficiency gains in the use of steel in DCa have occurred with a lag. This could be because of slower adaptation and diffusion of the material saving technologies that were developed and introduced in DMECa during the 1970s.

Wood

34. In the period 1974 to 1983 world consumption growth rates for wood were a 0.29 percentage point lower than at the beginning of the 1970s (table 2). This was entirely owing to the lower level of world GDP growth, whereas IU growth rates improved over the period and positively affected consumption growth. The improvement in IU growth rates continued into the 1980s and eventually offset the negative effect of lower GDP growth (table 3), thus producing in the period 1984 to 1988 an increase in consumption growth rates as compared to the period 1970 to 1973. As table 3 shows, the same pattern of improved IU growth rates can be observed in both DMECa and DCa. The improved growth rates of IU in the 1980s were maintained in the DMECa whereas DCa experienced a deterioration in IU growth rates, which was reflected in the lower growth of consumption in that region as compared to the early 1970s (table 3). Thus, during the 1980s in the DCa, IU growth rates failed to offset the effect of lower GDP growth. The higher world consumption growth rates of wood in the 1980s are thus the result of stronger demand in DMECa which was driven by an amelioration of the IU growth rates. 20/

(2) The relative effects of restructuring and intensity-of-use in manufacturing on the growth of commodity consumption

35. The results for the disaggregated effects of intersectoral restructuring and the evolution of IU in manufacturing (IUM) are presented in table 4. It considers the difference in the growth rates between 1970-1973 and 1974-1983. The post-1983 period is excluded from this part of the analysis, since for a large number of commodities and groups data were unsatisfactory. However, where it was possible to pursue the analysis beyond 1983 the results are

Interpreting the tables

30. The tables show the relative contribution of changes in the growth rates of GDP and IU to the difference in growth rates of commodity consumption. Thus, in table 2, the growth rates of ARMs consumption in the world were lower by two percentage points in the period 1974 to 1983 compared to the period 1970 to 1973. The results show that 93.5 per cent of that decline was attributable to the lower rates of GDP growth while 6.5 per cent was attributable to the lower rates of IU growth. All the results should be interpreted in this way. The case of wood is somewhat particular. In the case of world consumption of wood, the entire effect can be ascribed to the lower rates of GDP growth, whereas IU growth rates played an offsetting role. However, since the GDP effect was dominant, the average rates of consumption growth dropped by 0.29 percentage points.

ARMs

31. The decrease in the rates of world consumption growth of ARMs in the period 1974 to 1983 can be assigned almost entirely to the lower rates of growth of world GDP (i.e. 93.5 per cent of the decrease in the consumption growth rate was due to a decrease in the growth rate of GDP), which implies that technological advances and/or restructuring did not cause the lower rates of growth of consumption as compared to the previous period. However, it should be stressed that the IU growth rates were negative throughout the period 1970 to 1983 (-2.53 per cent per year), but since they did not deteriorate much between the two periods considered, the contribution of IU to the decreased growth rate of consumption is very low. The reason for the low explanatory power of the IU variable could be the result of the choice of periods compared. Empirical evidence at the micro-economic level suggests that intra-material substitution, rather than the development of material saving technologies, is the main channel through which technology affects demand for ARMs. The big technological breakthroughs in terms of the development of ARMs substitutes (mainly man-made fibres) occurred during the 1950s rather than the 1970s and led to reduced consumption growth rates prior to 1973. Thus, if one had compared the difference in rates of consumption growth in the 1950s and 1960s, one would probably have found a much larger contribution of IU to the differences in consumption growth. However, the limitations of available time series for crucial variables has meant that extending the period under analysis was not possible. Moreover, the IU variable encompasses both the restructuring and the technology effect, and as shown in section 2 below, the entire effect of the IU variable for the period 1974 to 1983 is the result of the declining share of manufacturing in GDP and the declining share of the textile industry within the manufacturing sector in the DMECs (see table 6). The immense improvement in the growth rates that occurred in the 1980s was the result of a dramatic increase in the demand for natural rubber, 17/ cotton, 18/ and hides/skins. 19/ The resulting increase in the IU totally offset the negative effect of lower GDP growth.

NFMMs

32. Non-ferrous minerals and metals (NFMMs) suffered a decline of 4.05 percentage points in their world growth rate between 1970 to 1973 and 1974 to 1983, approximately half of this being due to lower growth rates of GDP and the other half to lower growth rates of IU. At a regional level,

Table 3

Changes in the Average Rates of Growth of Commodity Consumption owing to IU and GDP
(1984 to 1988 compared to 1970 to 1973)

Materials	Difference in the growth rates of consumption 1970-1973 to 1984-1988	Owing to changes in	
		GDP	IU
WORLD			
ARMa	5.11	-0.10	1.10
NFMMa	-2.28	0.25	0.75
Steel	-1.93	0.28	0.72
Wood	0.53	-0.90	1.90
DMEC			
ARMa	3.67	-0.05	1.05
NFMMa	-1.63	0.20	0.80
Steel	-1.20	0.27	0.73
Wood	1.48	-0.20	1.20
DC			
ARMa	3.20	-0.45	1.45
NFMMa	-13.62	0.15	0.85
Steel	-5.70	0.30	0.70
Wood	-0.37	4.10	-3.10

Source: UNCTAD database.

Note: ARMa = agricultural raw materials
NFMMa = non-ferrous metals and minerals.

29. To understand the results in their right perspective, table 5 at the end of this chapter presents the average rates of growth of GDP and IU in DMECs, DCs and the world for the periods 1970 to 1973, 1974 to 1983 and 1984 to 1988. This permits a clearer understanding of the effects of growth rates and of the effects of the differences in the growth rates. The former is helpful for understanding in what periods and regions GDP and IU affected positively or negatively consumption growth rates, whereas the latter permits an analysis of the effects of the changes in the growth rates of GDP and IU on changes of commodity consumption growth rates.

commodities into groups, data with 12 decimals was used, which proved
too cumbersome for the final calculation. Secondly, part of the divergence
from the value of one is because of the interactive effect of GDP on IU,
since the GDP term was omitted while totally differentiating equation (2).

Table 3

Changes in the Average Rates of Growth of Commodity Consumption
owing to IU and GDP
(1974-1983 compared to 1970-1973)

Materials	Difference in the growth rates of consumption 1970-1973 to 1974-1983	Owing to changes in	
		GDP	IU
WORLD			
ARMs	-2.00	0.935	0.065
NFMMs	-4.05	0.48	0.52
Steel	-5.08	0.37	0.63
Wood	-0.29	6.10	-5.10
DMEC			
ARMs	-2.30	0.80	0.20
NFMMs	-3.75	0.51	0.49
Steel	-6.66	0.30	0.70
Wood	-1.28	1.40	-0.40
DC			
ARMs	-2.08	0.97	0.03
NFMMs	-12.39	0.18	0.82
Steel	-4.36	0.49	0.51
Wood	0.50	-3.90	4.90

Source: UNCTAD database.

Note: ARMs = agricultural raw materials
NFMMs = non-ferrous metals and minerals.

27. To facilitate comprehension of the analysis, table 1 summarizes the disaggregation of relevant variables. Section 1 below presents the findings for the decomposition of commodity demand for the world, DMECs and DCs using GDP and the intensity-of-use variable. In section 2, the intensity-of-use variable is disaggregated further to account for cross-sectoral restructuring and for the variation in the intensity of commodity use in manufacturing value added. This is an extension of the basic Tilton approach and is used in order to come closer to an estimate of the effects of technological progress on commodity use in final production. Table 6 at the end of this chapter presents the data on shifts within the manufacturing sector in the DMECs but no formal analysis is carried out to estimate the effects of this process on commodity demand. As can be implicitly inferred from the analysis, intra-sectoral changes in manufacturing appear to have played a major role in slowing down the growth of commodity consumption in DMECs. A more in-depth analysis of the figures contained in table 6 would necessitate data on sectoral commodity consumption which are not available for a good number of the investigated commodities at the country level.

Table 1

Tree of Disaggregation

(1) The relative effects of GDP and intensity-of-use on the dynamics of commodity consumption

28. This part of the paper examines individual effects of the changes in the average growth rates of GDP and intensity-of-use on the average growth rates of commodity consumption for the period 1970 to 1988. GDP figures were obtained using the United Nations Statistical Office constant 1980 US dollars series. 16/ Tables 2 and 3 present the differences in the average growth rates of consumption. Based on equation (3) above, columns 3 and 4 of the tables give the relative contributions of the difference in the rate of growth of the variables intensity of use (IU) and GDP to the difference in the growth rate of consumption. Where the effects of GDP and IU did not add up to one and the variations were of the order of +/-0.5 percentage points, the difference was assigned to each particular variable according to its weight. In those cases where the divergence was above 0.5, results are replaced by an asterisk. There are two reasons for the divergence from a total effect of one. First, to obtain the basic data before aggregating individual

of wood and natural rubber seem to resemble more the evolution of metal intensity-of-use than the dynamics of ARMs intensity-of-use. Since 1983, consumption of wood, natural rubber, cotton, aluminium and nickel per unit of GDP has increased. In contrast, for five commodities - sisal/abaca, jute, tin, manganese ore, tungsten - intensity of use has fallen to very low levels in OECD countries over the period as a whole. Although not immune to cyclical volatility, the steady pace of decline of the intensity of use for these commodities appears to reflect their substitution by other materials or their fall into disuse. 13\ Comparing the evolution of intensity of use of ARMs and metals in general, one can conclude that the latter seem to have been more dominated by inter-metal substitution whereas ARMs (with the exception of wood, natural rubber and cotton) have been subject to displacement by synthetic substitutes.

24. Figures VI to X in the annex depict the dynamics of consumption and intensity-of-use of industrial materials in DCs. Once again, ARMs emerge as the commodity group for which the use per unit of GDP decreased the most. Conversely, the intensity of metal use recorded constant growth, chiefly propelled by consumption of nickel, aluminium, lead and tungsten. 14\ Whereas all but two ARMs (natural rubber and wool) faced contractions of intensity-of-use, metal use per unit of GDP slid in only one case (tin). As in DMECs, intensity of sisal/abaca use fared worst. In fact, sisal/abaca was the only commodity recording a drop in consumption in DCs in the period under review. Both metals and ARMs have been very sensitive to recession. About two thirds of the total drop in intensity-of-use of ARMs, for example, occurred in the wake of recessions. Inter-metal substitution has played a minor role in DCs. Conversely, synthetic substitutes appear to have made considerable inroads into consumption of several ARMs.

25. The consumption-behaviour of wood in developing countries merits special comment. This paper attempts to estimate total consumption of coniferous and non-coniferous wood. While the use of wood for energy was an engine of consumption growth for wood in developed countries in the recent past, it is widely believed that this trend was shared by the South. However, the figures for wood consumption in DCs only fragmentarily take account of wood used for energy. Since this item accounts for about 43 per cent of total wood removals in developed countries, 15\ and can be expected to be even higher in the developing world, it must be assumed that the figures considerably underestimate actual wood consumption in DCs.

The relative contributions of various factors to consumption growth

26. The analysis is conducted for two groups of commodities (NFMMs and ARMs), whereas wood and steel are treated as individual commodities, both at the world level and country group level. Central and Eastern Europe, China and the socialist countries of Asia were excluded from this part of the study since the data for those countries was not comparable to the rest. Furthermore, owing to the unreliability of data at a disaggregated level, developing Africa is not included in world and DCs totals. Thus, "world" is defined as DMECs, developing America and developing Asia. The exclusion of Africa has only a marginal influence on the results for the world since Africa accounts for only 5 per cent of world commodity consumption volume. The exclusion of the other groups is a larger handicap since they roughly account for 40 per cent of total world consumption volume.

II. COMMODITY DEMAND GROWTH RATES: CAUSES FOR THEIR DECREASE

19. Over a number of decades, the intensity of raw material use has been declining in the industrialized countries, and since the mid-1970s, the growth of raw material consumption has been less buoyant compared to the 1960s. The decrease in raw-material consumption growth rates has been attributed to technological progress in manufacturing and the advent of new materials, lower GDP growth rates and the increased importance of sectors that do not use raw materials intensively (in particular, the services sector). In order to quantify the relative effect of these factors on consumption growth rates, this chapter presents the results obtained by using the intensity-of-use technique for the period 1970 to 1988.

20. The chapter comprises two parts. Part A presents the evolution of commodity consumption and intensity of material use. Part B looks at consumption trends of industrial commodities, and tries to identify their determinants. The analysis uses the extended Tilton technique, and evaluates the relative contributions of GDP, restructuring and technological change on raw-material consumption growth rates.

21. It should be noted that the effects of technological progress on final consumption do not necessarily reflect the full impact of technology on the production and demand for unprocessed raw materials. Mainly this is owing to technological advances in the recycling process, which have meant that for a number of commodities the level of final consumption might remain unchanged, although the required level of newly produced raw materials will decline. Thus, this report might underestimate the effects of technological progress on raw material exporting countries, and further research would be needed to estimate the full effect of recycling on raw material production. Moreover, the report does not address the question of the relative impact of technological progress on the supply of commodities, and the possible advantages accruing to a number of exporters as a result of technological advances that have led to decreased costs of production and thus increased price competitiveness.

A. Evolution of commodity consumption and intensity of material use

22. Figures I to V in the statistical annex portray the dynamics of consumption and intensity of material use of industrial commodities in the DMECs for the period 1965 to 1988. In the light of their weight, steel and wood have been treated individually.

23. For the period as a whole, agricultural raw materials (ARMs) emerge as the group whose intensity of use has decreased most, by about 55 per cent. Steel use per unit of GDP fell by 45 per cent and intensity of non-ferrous metal use slid by one third. Unlike ARMs, the Iron's share of the decrease of metal intensity-of-use occurred during the recessions, following the first and second oil price hikes. If the periods of recession are excluded, metal use per unit of GDP has only slightly eased over the period under review (in the case of steel by some 10 per cent; for non-ferrous minerals and metals (NFMMs), in the order of 10 to 15 per cent). The two step-like declines in metal intensity-of-use ought to be seen in the light of energy intensity of metal production and refining as well as the consequences of the new economic exigencies emerging from the crises. Intensities-of-use

Figure 1 : Raw Materials - Consumption in Developed Countries

27\ In the light of the amplitude of volatility of consumption in the post-1973 period, some of the projected trends for the remainder of this decade should be interpreted with caution. This applies in particular to the projections for NFMMs, steel and ARMs consumption in DMECs.

28\ At first sight, this result contradicts the trend plotted in figures XIII and XVII of the statistical annex. On closer examination one discovers, however, that projections strongly vary with the base periods selected. This is why the trend based on 1984-1988 consumption is much more positive than that calculated on the basis of actual consumption of ARMs in the period 1976-1988.

21\ In fact, in an effort to avoid this impasse, we attempted to exclude energy use from total wood consumption. The attempt failed, however, because about half of energy wood consumption in developed countries is based on the use of residues of primary processing (sawmilling, plywood\veneer manufacture, particle board manufacturing, pulp and paper production) although regional patterns vary widely. From a statistical point of view, this part of energy wood consumption is hidden in wood consumption figures of the primary processing industries mentioned. Although some estimates of residues consumption for energy production exist, they do not allow any systematic analysis at our level of disaggregation. For more information see footnote 22.

22\ The sectoral pattern of steel, *aluminium* and wood consumption signify a heterogeneous evolution of the share of building and construction in three of the most important consuming countries: United States of America, United Kingdom and Japan. While in general the share of construction in consumption has been on a decline, its pace and direction have varied among countries. The evolution of the share of building and construction in total consumption can be summarized as follows:

	United States		United Kingdom		Japan	
	1973	1983	1973	1983	1973	1983
Steel	28	30	17	15	47	45
Aluminium	26	22	10	19	34	31
Wood	40	32	45	36	39	30

International Iron and Steel Institute, Inter-material Competition: An Economic Analysis of General Trends, Committee on Economic Studies, Brussels, 1989, pp. 2-22 to 2-24.

23\ It should be noted that this is a strong assumption, and that more empirical research needs to be undertaken in this field.

24\ For more details, see "An analysis of the evolution of demand for cotton", UNCTAD\COM\4, 1990.

25\ The good performance of rubber was already noticeable during the 1980s. In the report "Impact of New and Emerging Technologies on Trade and Development", (TD\B\C.6\136, UNCTAD 1986) attention was drawn to the fact that increased competition from other materials had accelerated R & D efforts with the objective of defending the position of natural rubber. Indeed, this effort resulted in greater uniformity of quality of rubber, and enabled it to recapture part of the radial tyre market (see op. cit., p. 5 para. 8)

26\ Hwang, Lee H., "Intensity of Steel Use in the Less Developed Countries: The case of Korea" - Ph.D. dissertation, Colorado School of Mines, Golden 1989.

18/ Cotton is the only natural fibre which has successfully competed against synthetic fibres and which is still the leader in its market. One of the reasons for its strength is that the chemical industry has never been able to duplicate some of the qualities of cotton at a competitive price. Indeed, one of the problems in comparing the evolution of cotton versus synthetic fibres is that they do not compete perfectly in all their end-uses. There have been applications of polyester for end-uses for which cotton has never been suitable and vice-versa. Furthermore, recent trends confirm that consumer preferences had led to increase the share of cotton within the mix of cotton and man-made fibres for spinning from 71 per cent in 1980 to 73 per cent in 1986, thus lifting the share of cotton in global consumption of fibres for home use in DMECs from 38 per cent in 1984 to 41 per cent in 1987. UNCTAD, An Analysis of the Evolution of Demand for Cotton, UNCTAD/COM/4, Geneva 1990.

19/ Hides and skins are by-products of livestock farming undertaken primarily for meat and wool. Therefore, prices of hides and skins have little or no effect on the quantity or quality produced. World supplies of hides and skins expanded less rapidly than demand for leather during most of the 1970s and 1980s. Thus, rather than displacing leather in its principal end-use - footwear uppers for the mass-market - synthetics and textiles have filled a gap in supply of leather from bovine, ovine and caprine origins. The main reason for the pick-up of hides/skins' demand in DMECs in the 1980s is that a growing proportion of supply has been utilized in outlets such as clothing and upholstery (both for furniture and motor cars) rather than in footwear (the estimated proportion of footwear in total consumption of light leather in DMECs has fallen below 50 per cent since the mid-1980s). Such leathers competed on design and consumer appeal rather than on price. FAO, The World Hides, Skins and Derived Products Economy: Global Analysis of Recent Developments and Future Outlook, ESC/M/86/5, Rome 1986; FAO, Current Situation and Short-Term Outlook for the Market of Hides and Skins, Second Session of the Sub-Group on Hides and Skins of the Intergovernmental Group on Meat, CCP: ME/HS 89/2, Rome 1989.

20/ As may be seen in figure V in the statistical annex, wood demand was very brisk in DMECs in the 1980s. In fact, in some market segments (e.g. residues, chips and particles for pulpwood production) supply shortages occurred. In general, wood demand was driven by enhanced supply requirements for housing, communication and packaging. Paper and paperboard experienced record demand in North America, Europe and Japan in 1986 to 1988. Another impulse came from enhanced use of wood-derived energy. Between 1980 and 1985, it grew much faster than total consumption of forest products (by 6 per cent a year in Europe and 4.6 per cent in the United States). In particular, private households and the forest industries substituted wood for other fuels (the consumption of wood energy by forest industries in DMECs in the period 1980 to 1985, for example, increased by almost 30 per cent). Altogether private households and forest industries consumed about 90 to 95 per cent of all energy wood. The fast growth in demand for energy wood must be seen as a direct and probably reversible, consequence of high oil prices. ECE/FAO, Survey of Medium-Term Trends for Wood Raw Material, Notably Pulpwood, and Wood for Energy, op. cit.

11\ See P.D. Canavan, The Determinants of Intensity-of-Use: A Case Study of Tin Solder End Uses, Ph.D. dissertation, Pennsylvania State University 1983; F.R. Demler, The Nature of Tin Substitution in the Beverage Container Industries, Ph.D. dissertation, Pennsylvania State University 1980; D.G. Gill, "Tin Chemical Stabilizers and the Pipe Industry", in: U.E. Tilton, Material substitution: Lessons from tin-using industries, Resources for the Future, Washington D.C. 1983, pp. 76-112.

12\ Boum-Jong Choe, Global Trends in Raw Materials Consumption, draft, International Economics Department, The World Bank, November 1990 and Structural Changes in Metals Consumption, Working Papers, No. 180, International Economics Department, The World Bank, April 1989.

13\ In some cases, technological innovation led to the disappearance of entire end-uses. A case in point is jute where new methods of bulk handling made the use of bags almost redundant.

14\ The volatility of the consumption of tungsten and the decline in consumption after 1985 call for a comment. Tungsten consumption in DCs is concentrated in a few countries such as Brazil, India and the Republic of Korea. The latter has accounted for at least two thirds of DCs total consumption in the last few years. Any economic difficulties encountered by these countries have thus a severe bearing on tungsten consumption. In general, tungsten consumption correlates with steel consumption which peaked at a very high level in DCs in 1985. Moreover, tungsten consumption, notably in Asia, has been influenced by the brisk expansion of tungsten production and export by China after 1983.

15\ ECE, Survey of Medium-Term Trends for Wood Raw Material, Notably Pulpwood, and Wood for Energy, Timber Bulletin vol. XLII, No. 2, New York 1990, p. 30.

16\ The problem of over- or under-estimation, which arises owing to the choice of the exchange rate for that particular year is avoided since this study only deals with rates of growth of GDP and not with its levels. Since the whole series is multiplied by the same constant (the 1980 exchange rate), the rates of growth obtained are not affected by the choice of the base year.

17\ In the post-1982 period, demand for natural rubber has profited from a decline in the relative price of natural rubber vis-à-vis synthetic rubber (a decrease in the order of 10-20 per cent). With less concern about high and increasing oil prices, the trend towards miniaturization of cars and thus lower rubber input appears to have been arrested. In particular, the large-scale production of high-performance and all-season tyres fuelled natural rubber demand (in the United States market the share of high-performance tyres reached almost 20 per cent in 1986). Furthermore, technological improvements which led to enhanced quality allowed natural rubber to make inroads into spare parts dominated by synthetic rubber in the past. There has also been a surge in latex concentrate demand since 1986 by the medical insulation industry lifting the share of latex concentrate in total natural rubber consumption from 8.5 per cent in 1985 to 10 per cent in 1988. World Bank, Price Prospects for Major Primary Commodities, vol. II, Washington D.C. 1988, pp. 289-309.

Notes

1/ See UNCTAD Commodity Yearbook 1990, TD/B/C.1/STAT.7, New York 1990.

2/ In terms of coverage, commodity demand equals ultimate commodity absorption plus losses occurring at different levels of manufacturing, trade and consumption. Even so, in our study, the terms consumption and demand are used interchangeably. Since it is our intention to measure commodity consumption as close as possible to total absorption, it is of little significance whether commodities are "consumed" while embodied in manufactures or as waste.

3/ The calculations on the evolution of the intensity of use are based on consumption figures for raw materials including semi-fabricates and recycled materials. This data was compiled by the Commodities Division, UNCTAD. For a detailed explanation of the methodological aspects regarding the analysis of consumption figures including recycled materials and semi-fabricates, see "Demand growth for Industrial Raw Materials and its Determinants: An Analysis for the Period 1965-1988", UNCTAD Discussion Paper Number 50, November 1992, by Ulrich Hoffmann and Dusan Zivkovic.

4/ John, E. Tilton, "The New View of Minerals and Economic Growth", The Economic Record, vol. 65, No. 190, Canberra, September 1989.

5/ See: "Impact of New and Emerging Technologies on Trade and Development", TD/B/C.6/136, UNCTAD 1986; "Impact of Technological Change on Patterns of International Trade", UNCTAD/ITP/16, UNCTAD/ITP/TEC/3, UNCTAD 1989; "Trade and Development Opportunities and Implications of New and Emerging Technologies: The case of Biotechnology", TD/B/C.6/154, UNCTAD 1991.

6/ Agricultural raw materials: jute, wool, cotton, natural rubber, tobacco, sisal/abaca, hides/skins. Non-ferrous minerals and metals: manganese, phosphate, aluminium, copper, lead, tin, nickel, zinc, tungsten. Separately considered: wood, steel.

7/ W. Malenbaum (1985), "Law of Demand for Minerals", Proceedings of the Council of Economics, 104th Annual Meeting of the American Institute of Mining, Metallurgical and Petroleum Engineers, pp. 146-155.

8/ D. Humphreys, "Perspectives on Intensity of Use", Materials and Society vol. 11 (1987), No. 3.

9/ J. Dean, "Pricing Policies for New Products", Harvard Business Review 28 (1950), pp. 45-53.

10/ G.W. Bain, "Production Growth Rates as an Index for the Amount of Total Resource", Proceedings of the Eleventh Commonwealth Mining and Metallurgical Congress, Hong Kong, 1978, IMM, London.

V. MATHEMATICAL APPENDIX

Rewriting the consumption equation (1) in a different form, we get:

$$C = GDP * C * GDP_{-1}$$

Totally differentiating,

$$dC = (C*GDP_{-1} - C*GDP*GDP_{-2})\, dGDP + (GDP*GDP_{-1})\, dC$$

Dividing by C

$$dC/C = \{(C*GDP_{-1})\backslash(C*GDP*GDP_{-1})\}\, dGDP - \{(C*GDP*GDP_{-2})\backslash(C*GDP*GDP_{-1})\}\, dGDP + \{(GDP*GDP_{-1})\backslash(C*GDP*GDP_{-1})\}\, dC$$

And simplifying

$$dC/C = dGDP\backslash GDP + [GDP_{-1}\, dC - (C*GDP_{-2})\, dGDP\,]\backslash(C*GDP_{-1})$$

Note that $C*GDP_{-1}$ is the intensity of use (IU), and that

$$[GDP_{-1}\, dC - (C*GDP_{-2})\, dGDP] = q(C\backslash GDP) = qIU$$

Thus,

$$dC/C = dGDP\backslash GDP + qIU\backslash IU$$

It should be stressed that the term qIU\IU is in itself affected by dGDP, i.e. changes in the gross domestic product affect the rate of growth of the intensity of use. Therefore, the estimates of the relative effects of the GDP and IU variable understimate the effect of the contribution of GDP. However, this is a second order effect, and it was assumed that it does not alter the results significantly.

Abbreviations

ARM	Agricultural raw material
GDP	Gross domestic product
DMEC	Developed market economy country
DC	Developing country
IUM	Intensity-of-use in manufacturing
IUT	Intensity-of-use technique
NFMM	Non-ferrous minerals and metals
NICs	Newly industrializing countries
RES	Restructuring
UNSO	United Nations Statistical Office

hypothesis of uncoupling to hold, the correlation between growth of commodity demand and growth of GDP should be low. Since the IU growth rates for a good number of commodities have stabilized (at negative levels in OECD countries) with no signs of accelerated decline, it can be expected that the growth rates of GDP and the growth rate of commodity consumption in DMECs will be moving in the same direction (but not necessarily fluctuating in the same magnitude) during the 1990s.

65. Since the major part of intra-material substitution between man-made fibres and natural fibres took place during the 1960s, the choice of the periods analysed has an important impact on results concerning the apparently small effect of technological change on agricultural raw materials. Moreover, the conclusions in this paper concern the role of the differences in the growth rates of GDP, restructuring and intensity-of-use in manufacturing rather than the role of the growth rates per se. Thus, it was found that technological progress has negatively influenced the IU trends throughout the period 1965 to 1988, but that there was no increased contribution of this effect to commodity demand trends in the post-1973 period.

66. In general, synthetic substitutes have made far more inroads into ARMs than into metals. The latter have been subject to intra-metal substitution from old in favour of new metals, particularly in the case of aluminum and nickel.

IV. CONCLUDING REMARKS

61. This paper has attempted to analyse and assess the relative contribution of various factors (GDP growth, technological progress and economic restructuring) to the dynamics of consumption of the most important industrial commodities. The attempt to broaden the intensity-of-use technique as employed by Tilton in order to account for the effects of technological change and restructuring on commodity consumption has, however, been only partly successful. It was not possible to assess the full effect of restructuring on the dynamics of commodity consumption. The effects of intra-sectoral restructuring in manufacturing remained outside the purview of this analysis, owing to the lack of estimates of the volume of sectoral material consumption at the country level. Even so, there are indications that changes in the pattern of manufacturing branches have been the factor putting the main brake on the growth of material consumption in DMECs over the last two decades. In the light of the above, the gathering of consistent data on sectoral commodity consumption should become an important area for future research.

62. Despite the conceptual limits in disaggregating the contribution of various factors to the growth of commodity consumption, this study suggests that the decreased growth rates of commodity consumption cannot be attributed to an acceleration of technological change in the DMECs. In fact, the higher rate of technology diffusion in DCs, in particular in the Asian NICs, has had a large impact on commodity demand growth rates in the South. Considering that the major part of technological innovations takes place in the DMECs, this implies that technological progress, in so far as it affects commodity consumption, was not significantly affected by the 1973 oil price hike (i.e. technological innovation seems to be an exogenous factor with respect to the macroeconomic environment). Despite the micro-computer revolution, the introduction of state-of-the art technology does not appear to have accelerated in DMECs after 1973. In contrast, in DCs, its introduction and diffusion quickened. This is why (with the exception of steel) the IU effect on commodity demand was much larger in DCs throughout the period 1973 to 1988.

63. The slowdown of growth rates of commodity demand is only partly attributable to cyclical factors, the rest of the decrease in the growth rates has to be ascribed to the process of restructuring which is irreversible and can thus be interpreted as a "structural" cause of the decline in growth rates. Moreover, the process of industrialization in the DCs gives only a limited possibility for a substantial increase in the growth rates of commodity demand owing to the adverse effects of leap-frogging. As shown in chapter III, the recovery of demand growth rates of non-ferrous metals and of steel to their pre-1973 levels requires extremely high growth rates of GDP and\or IU in DCs in the 1990s. DCs have already become the main consumer of ARMs. However, if trends of commodity consumption remain unchanged, DMECs will retain their position as principal consumer of metals. In fact, this group of countries will continue to account for more than half of world consumption of all technologically and economically important materials.

64. The results presented in this paper lend only limited support to the hypothesis of "uncoupling" of commodity demand growth from the growth of GDP. As was shown in chapter II, the decreased rates of growth of GDP accounted for a non-negligible proportion of the decline of growth rates of commodity demand. For the purposes of clarification, it should be noted that for the

As can be seen, under both scenarios the required rates of growth of GDP and IU are highly unrealistic and it is therefore unlikely that DCs can bring about a major turnaround in the world consumption growth of NFMMs in the 1990s.

Steel

57. It was possible to obtain a longer data series for steel; thus 1966-1973 is taken as a base period. The same method is applied as in the previous case. So as to achieve world consumption growth of 6.2 per cent during the 1990s, consumption in DCs would have to grow at an average annual rate of 13.5 per cent. But, the respective rates of growth of GDP and IU were:

GDP (1984-1988) = 4.1 per cent
IU (1984-1988) = 5.0 per cent

58. Holding the rate of GDP growth at the level of the 1980s implies an IU growth rate of 9.4 per cent per annum, which is nearly double its growth rate in the 1980s. Moreover, taking into account that steel IU growth rates have been slack, there is not much evidence to suggest a dramatic reversal in the rates of growth of steel IU in DCs. Assuming a stable rate of growth for IU necessitates a 8.5 per cent growth rate of GDP per annum for the DCs as a group, in the 1990s, in order to achieve a consumption growth rate of 13.5 per cent, all Developing Countries would have to replicate the success story of the east Asian NICs in terms of GDP growth.

Wood

59. Estimates for wood have not been made since the rates of growth of world consumption of this material have recovered and even exceeded the rate achieved at the beginning of the 1970s. The recovery is entirely owing to the higher rates of growth in the DMECs, which in the case of wood is linked to the enhanced use of wood for energy production and the recent shift in consumer taste. As a consequence, the decline in the intensity of wood use in DMECs has almost been arrested in the 1980s.

IU (1970-1973) = -2.9 per cent
IU (1984-1988) = -0.4 per cent

ARMs

60. The case of agricultural raw materials is similar to that of wood, growth in the 1980s being well above that achieved during the 1970s. Therefore no calculations have been carried out. 28\ The recovery of ARMs consumption growth is owing to both the higher rates of growth of consumption in DMECs and in DCs and in particular the good performance of natural rubber, cotton and hides/skins. In the case of ARMs, the "golden age" of high growth rates of consumption was in 1950s before the advent of man-made fibres which virtually wiped off some natural fibres in a number of end-uses during the 1960s and 1970s (notable examples being sisal and jute). Therefore, the choice of the early 1970s as a base year establishes a very low base from which to measure performance in the 1980s. While the 1980s was a better period for ARMs in general than the 1970s, recovery has not been evenly spread across all commodities.

Table 8

Average annual rates of growth of Commodity Consumption
under the scenario assumptions

Period	NFMMa			Steel		
	World	DMECa	DCa	World	DMECa	DCa
1970-1973	4.9	3.7	18.9	6.2 a/	5.7 a/	9.8 a/
1984-1988	2.6	2.1	5.2	3.0	1.2	9.0
1989-2000	(4.9)	(2.1)	12.8	(6.2)	(1.2)	13.5
	Wood			ARMa		
1970-1973	2.4	1.8	2.8	1.8	0.5	3.6
1984-1988	2.4	3.1	1.9	6.9	4.2	6.8
1989-2000	...	...	...	...	...	...

Note: The figures in parenthesis constitute the assumptions for the projected rate of material consumption growth in developing countries during the 1990s.

a/ For the period 1966-1973.

NFMMa

55. Assuming Ca(1989-2000) is the same as in the 1980s, i.e. 2.1 per cent and imposing Cw(1989-2000) is the same as in the 1970s, the necessary rate of growth of consumption in DCs for the period 1989-2000 is calculated. Thus,

Cb(1989-2000) = 12.8 per cent

i.e. the average annual growth rate of consumption would have to be well above that of the 1980s in order to produce a world recovery. Note that the growth rate of consumption is the *sum* of the rate of growth of GDP and of the intensity of use.

$$\dot{C}b = \dot{G}Dpb + \dot{I}Db$$

Thus, the combined growth rates of GDP and UI in DCs would have to equal 12.8 per cent annually in order to generate yearly world consumption growth rates of 4.9 per cent. However, in DCs, during the 1984 to 1988 period, GDP and UI grew by 4.1 per cent and 1.1 per cent respectively.

56. Assuming the rates of growth of GDP remain at their 1980s' levels throughout the 1990s, UI would have to grow at 8.8 per cent per year, which is unlikely considering the recent evolution of UI in DCs. The other possibility is to assume the same rates of growth of UI and calculate the necessary rate of growth of GDP. With UI growth rates unchanged in the 1990s, GDP would have to grow at 11.7 per cent per year in order to boost world consumption growth.

B. Can the 1990s bring about a turn in growth rates of commodity consumption?

52. A large part of the debate on commodity consumption trends has been centred around the question of the potential role of DCs as major end-users of raw materials. Since the intensity of use in DMECs is decreasing and is likely to continue to do so in the future, thus negatively affecting the growth rates of raw materials demand, the only possibility for the demand growth rates to increase vigorously on the world level would be a continued expansion of raw materials demand coming from DCs. In order to investigate this possibility, the paper simulates demand growth rates in DCs using varying assumptions about the growth rates of GDP and the evolution of intensity of use needed to generate an expansion in world demand for commodities.

53. The sensitivity analysis is aimed at answering the following question: "If commodity growth rates in DMECs remain at their average 1980s levels during 1990s, what rates of growth of consumption in DCs in the 1990s would be needed to generate world growth rates equivalent to those experienced in the late 1960s and early 1970s"?

54. The following method is used for obtaining the estimates:

$$Cwt = Cat + Cbt \qquad (1)$$

where : Cwt = World consumption at time t
Cat = Consumption in DMECs at time t
Cbt = Consumption in DCs at time t

Totally differentiating (1) and multiplying by each term,

$$Cwt = Cat(Cat/Cw) + Cbt(Cbt/Cwt) \qquad (2)$$

the sum of regional growth rates in period t multiplied by the relative share of each region in world consumption in period t.

By imposing

$$Cw(1970\text{-}1973) = Cw(1989\text{-}2000) \qquad (3)$$
$$Ca(1984\text{-}1988) = Ca(1989\text{-}2000) \qquad (4)$$

and allowing Ca/Cw and Cb/Cw to change over time, the required level of Cb (1989-2000) to satisfy the equation given in (3) is calculated. The analyses uses the relative weights of regions for 1988 and 2000; a calculation of the average weight for the period is given rather than calculating the yearly weights; this yields somewhat biased results since it underestimates the required Cb at the beginning of the period and overestimates it for the end of the period. However, the average required rate of growth is not biased despite the methodology used. Table 8 summarizes the estimated rates of growth of consumption in DCs in the 1990s which would generate growth rates of world commodity consumption volume equal to those recorded in the late 1960s and early 1970s.

Furthermore, these countries preserved their overwhelming role as consumers of the most dynamic and multiple-use commodities, i.e. aluminium, nickel, copper, steel and natural rubber. However, projected consumption to the end of the century based on actual consumption in the period 1976 to 1988 suggests a continuation of the shift in favour of DCs. Even so, by the year 2000, DMECs will continue to retain their dominant position as the principal consumer of metals. In fact, this group of countries will continue to account for more than half of world consumption of all technologically and economically important commodities (even in steel consumption, DMECs will retain a weight double that of DCs).

Table 7

Share of Developed and Developing Countries in World Consumption of Industrial Commodities
1970, 1988, 2000 a/

	1970		1988		2000 b/	
Commodity	DMEC	DC	DMEC	DC	DMEC	DC
Non-wood ARMs	60	30	28	37	22	38
Jute	36	45	7	41	0	39
wool	61	11	37	22	27	27
cotton	32	28	28	38	25	37
natural rubber	62	15	50	32	45	37
tobacco	38	32	23	28	12	26
sisal/abaca	68	26	32	39	26	59
hides/skins	41	36	31	45	26	48
Wood	34	40	33	45	32	47
MFMMs	67	7	45	20	34	28
manganese	53	5	31	14	9	19
phosphate	66	7	39	23	27	31
aluminium c/	93	7	86	14	81	19
copper	79	6	69	14	66	19
lead	67	8	59	15	52	21
tin	74	8	58	17	45	23
nickel	77	1	69	8	64	12
zinc	68	9	55	18	49	22
tungsten	61	0	35	7	15	11
Steel	66	7	46	15	35	18

Source: UNCTAD database.

a/ The percentages do not add up to 100 per cent since Central and Eastern Europe as well as China, Mongolia, Democratic People's Republic of Korea and Viet Nam are not included owing to data deficiencies.

b/ Projected on the basis of a linear trend for consumption during the period 1976-1988.

c/ Western world only.

III. COMMODITY DEMAND UNTIL THE YEAR 2000: SENSITIVITY ANALYSIS AMONG THE MAIN DETERMINANTS

47. Based on the extended coverage of the volume of commodity consumption and the decomposition into its driving forces, this chapter sets out to investigate the relative sensitivity of these driving forces in the decade ahead. The sensitivity analysis is conducted in two steps: (a) linear projections of commodity consumption based on actual behaviour of the determinants of commodity demand in the period 1976-1988; (b) an investigation of the conduct of the determinants of commodity consumption growth to meet certain criteria in the 1990s. This is not a mere arithmetic exercise but an attempt to ascertain the band width for commodity demand in general and the role that DCs may play as increasingly important consumers of raw materials.

A. The relative weights of regions in world consumption

48. The post-1973 period marked a sharp change in the growth of raw materials consumption. Figures XI to XVIII in the statistical annex show the actual and projected trends of raw materials consumption based on two assumptions: first, what the trend in consumption would have been had growth rates of the period 1965-1973 remained unchanged during the 1970s and 1980s; secondly, the linear trend of consumption of the main commodity groups to the end of this century under the assumption that the dynamics of consumption recorded in the period 1976-1988 remain unaltered.

49. In analysing the results, one should bear in mind that projections to the year 2000 do not account for changes in the economic systems in Central and Eastern Europe nor impending reforms in socialist Asia. Such changes would have a major bearing on the relative weights of regions in world material consumptions. Furthermore, it is worth stressing that the projections for some commodities (for example tungsten) are biased since they do not reflect the volume of material embodied in export/import of semi-fabricates by countries in Central and Eastern Europe or in socialist Asia.

50. As may be seen from the charts, the projected trends to the year 2000 for DMECs are not only at variance with the trends based on 1965 to 1973 consumption but also have a negative slope except for wood. 27/ In contrast, projections up to the year 2000 for DCs depict a steeply ascending slope. Moreover, trends to the end of the century surpass the increase in DCs' consumption projected on the basis of 1965-1973 figures in two cases: NFMMs and wood. It is clear from the graphs that global commodity consumption in the 1990s (excluding the case of wood) can only become briskier if DCs gain weight in world consumption.

51. Before examining the economic preconditions for restoring growth of commodity consumption to the pre-1973 level (see second part of this chapter) a brief look at the evolution of the weights of developed and developing countries in world commodity consumption is warranted. Table 7 attempts to visualize the role that DCs have played and may be assuming in world commodity consumption to the end of this century, (the economic environment kept unchanged). As far as developments in the past are concerned, DCs have more than doubled their share in global metal consumption and have become the key consumer of ARMs in the 1980s. This does not alter the fact that DMECs have nevertheless continued to be the main market for minerals and metals.

Figure XV
Consumption Trends of Non-fer. Min./Metals in Developing Countries
Non-F MVM - Actual Consumption
Trend - NFMM 1985/73
Trend - NFMM 1972/88
1100
1050
1000
950
900
850
800
750
700
650
600
550
500
450
400
350
300
250
200
150
100
50
65 66 67 68 69 70 71 72 73 74 75 76 77 78 79 80 81 82 83 84 85 86 87 88 89 90 91 92 93 94 95 96 97 98 99 20 00

Figure XIV
Consumption Trends of Wood in Developed Countries
Wood - Actual Consumption
Wood - Trend 1965/73
Wood - Trend 1974/88

Figure XIII
Consumption Trends of Agr. Raw Materials in Developed Countries
ARM - Actual Consump.
ARM - Trend - 1965/73
ARM - Trend - 1974/88
170
165
160
155
150
145
140
135
130
125
120
115
110
105
100
95
90
85
65 66 67 68 69 70 71 72 73 74 75 76 77 78 79 80 81 82 83 84 85 86 87 88 89 90 91 92 93 94 95 96 97 98 99 00

Figure XII
Consumption Trends of Steel in Developed Countries
Steel - Actual Consumption
Steel - Trend 1965/73
Steel - Trend 1974/88
550
510
500
490
480
470
460
450
440
430
420
410
400
390
65 66 67 68 69 70 71 72 73 74 75 76 77 78 79 80 81 82 83 84 85 86 87 88 89 90

Figure IX
Consumption Trends of Non-fer. Min./Metals in Developed Countries
Non-F MM - Actual Consumption
Trend - NFMM 1985273
Trend - NFMM 1976188
180
175
170
165
160
155
150
145
140
135
130
125
120
115
110
105
100
55 56 57 58 59 60 61 62 63 64 65 66 67 68 69 70 71 72 73 74 75 76 77 78 79 80 81 82 83 84 85 86 87 88 89 90 91 92 93 94 95 96 97 98 99 20 00

Figure X
Steel and Wood Consumption and Intensity of Use in Developing Countries
steel - ion
wood - ion
steel - co
wood - co

Figure IX Non-fer. Min./Metals - Internl - Steel Use in Developing Countries
NON-FERROUS
MANGANESE ORE
PHOSPHATE ROCK
ALUMINUM
COPPER
LEAD
TIN
NICKEL
ZINC
TUNGSTEN
25
50
75
100
125
150
175
200
225
250
275
300
325
350
375
400
425
450
475
500
525
550
575
600
625
650
675
700
725
750
775
800
825
850
875
900
925
950
975
1000
1025
55 56 57 58 59 60 61 62 63 64 65 66 67 68 69 70 71 72 73 74 75 76 77 78 79 80 81 82 83 84 85 86 87 88

Figure VIII.1: Mineral Resources - Consumption in Developing Countries
2000
1950
1900
1850
1800
1750
1700
1650
1600
1550
1500
1450
1400
1350
1300
1250
1200
1150
1100
1050
1000
950
900
850
800
750
700
650
600
550
500
450
400
350
300
250
200
150
100
50
55 56 57 58 59 60 61 62 63 64 65 66 67 68 69 70 71 72 73 74 75 76 77 78 79 80 81 82 83 84 85 86 87 88
Non-fuel MM
manganese ore
phosphate rock
aluminium
copper
lead
nickel
nil
zinc
tungsten

Figure VII Agr. Raw Materials - Intensity of Use in Developing Countries

Figure VI Agr. Raw Materials - Consumption in Developing Countries

Figure V Steel and Wood - Consumption and Intensity of Use in Developed Countries

Figure IV
Non-fer. Minerals - Intensity of Use in Developed Countries
Non-f. MM
manganese ore
phosphate rock
aluminium
copper
lead
tin
nickel
zinc
tungsten
140
130
120
110
100
90
80
70
60
50
40
30
65 66 67 68 69 70 71 72 73 74 75 76 77 78 79 80 81 82 83 84 85 86 87 88

Figure III Non-fer. Min/Metals - Consumption in Developed Countries
Non-f. MM
magnesium
phosphorus
aluminium
copper
lead
tin
nickel
zinc
tungsten
210
200
190
180
170
160
150
140
130
120
110
100
90
80
70
60
65 66 67 68 69 70 71 72 73 74 75 76 77 78 79 80 81 82 83 84 85 86 87 88

Figure II Agr. Raw Materials - Intensity of Use in Developed Countries

Figure XVIII

Figure XVII

Consumption Trends of Agr. Raw Materials in Developing Countries

Figure XVI

Consumption Trends of Steel in Developing Countries